HERBAGE RESPONSE AFTER MECHANICAL AND HERBICIDE TREATMENT OF BIG SAGEBRUSH IN SOUTHWEST IDAHO

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ABSTRACT

Understory vegetation showed a distinct yield increase after killing sagebrush with herbicides or after grubbing off sagebrush in southwestern Idaho. Response of underlying vegetation was greatest at sites receiving 17 inches or more of precipitation. Herbicide spray offered the most effective long-term control of sagebrush. Sagebrush regrowth was observed 5 years after grubbing off sagebrush.

KEYWORDS: *Artemisia tridentata*, big sagebrush, herbicide, herbage yield, Idaho rangeland, plant composition, 2,4-D.

CONTENTS

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HERBAGE RESPONSE AFTER MECHANICAL AND HERBICIDE TREATMENT OF BIG SAGEBRUSH IN SOUTHWEST IDAHO

By

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INTRODUCTION

The sagebrush-grass region of Idaho covers about 17 million acres, and is the largest grazing region in the State (*12*).[2] Several studies indicate that brush control practices such as burning or the use of herbicides or mechanical devices may decrease some of the sagebrush and increase forage yield in this region (*4*, *5*, *7*).

The variation in plant communities and annual precipitation amounts on the Reynolds Creek Experimental Watershed offered an excellent opportunity to study the effects of sagebrush control on grass and forb responses. The watershed is located in southwest Idaho (fig. 1) at elevations that range from 3,900 feet, where the annual precipitation is about 10 inches per year, to over 7,000 feet, where the precipitation is greater than 45 inches per year. Big sagebrush (*Artemesia tridentata*) is the dominant plant species on much of the watershed, which represents a large area of the Snake River Plains and Northern Great Basin (*10*).

We designed this study to determine the effects of herbicide and mechanical sagebrush control on forage yields for 1971-75, under different annual precipitations, as compared with adjacent grazed and ungrazed areas without brush control.

STUDY AREAS AND METHODS

Study Areas

The four study sites are located at elevations ranging from 4,600 feet near Nancy Gulch to 6,800 feet near Reynolds Mountain. While all sites had a dense sagebrush cover, average annual precipitation varied from 13 inches at Nancy Gulch to 45 inches at Reynolds Mountain (table 1). Since drifting snow accumulates at the Sheep Creek and Reynolds Mountain sites, more water is available for plant use. Most of the precipitation at these sites is in the form of snow. Precipitation at all sites occurs primarily during winter and early spring.

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[2]Italic numbers in parentheses refer to Literature Cited, page 13.

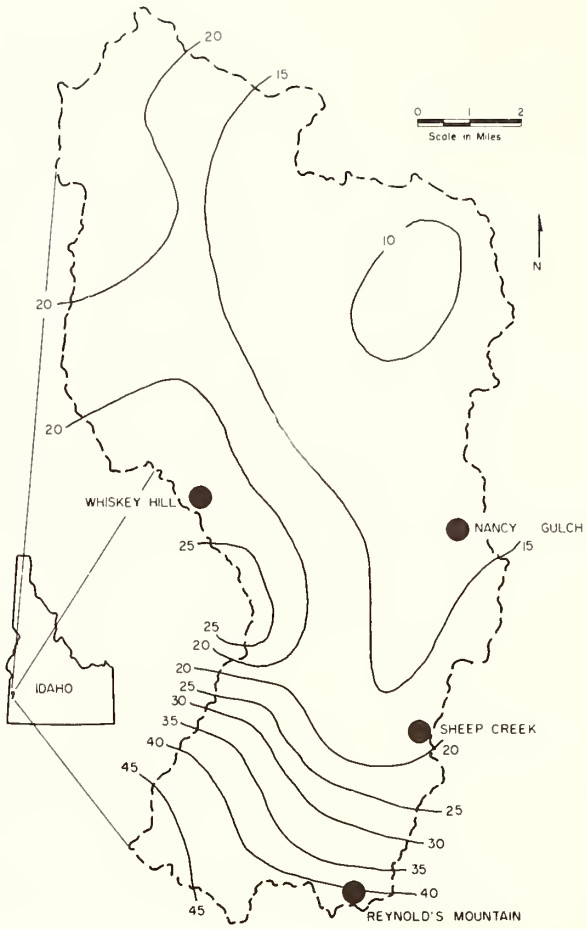

Figure 1.--Isohyetal map with the locations of the four study sites, Reynolds Creek Experimental Watershed, southwest Idaho. Numbers indicate inches of rainfall per year.

TABLE 1.--*Elevation, annual precipitation, slope, and aspect at brush treatment study sites*

Site	Elevation above sea level	Precipitation	Slope	Aspect
	Feet	*Inches/year*	*Percent*	
Nancy Gulch	4,600	13	8	NE
Whiskey Hill	5,500	23	15	E
Sheep Creek	6,100	20[1]	33	NE
Reynolds Mountain	6,800	43[1]	6	N

[1]Receives additional water from drifted snow.

Soils at the study sites were derived from basalt, granite, or rhyolite; soil textures varied from loam to gravelly loam (table 2).

TABLE 2.--*Geologic material and soil characteristics at brush treatment study sites*

Site	Geologic Material	Soils		
		Subgroup	Family	Series
Nancy Gulch	Basalt	Aridic Calcic Argixerolls	Fine loamy, mixed, mesic	Babbington loam
Whiskey Hill	Granite	Typic Haploxerolls	Coarse loamy, mixed, frigid	Takeuchi rocky coarse sandy loam
Sheep Creek	Basalt	Argic Pachic Cryoborolls	Fine loamy, mixed	Harmehl and Demast loam
Reynolds Mountain	Rhyolite	Pachic Cryoborolls	Fine loamy, mixed	Bullery gravelly loam

Treatments

Exclosures of approximately one-half acre were fenced before brush treatment (fig. 2), while the surrounding areas were grazed. Herbicide was applied

Figure 2.--View of the exclosure at Sheep Creek. Treatments shown are, *left*, mechanical removal of sagebrush; *center*, spray treatment; and, *right*, untreated (ungrazed area).

in May or June when new growth of sagebrush was 3 to 4 inches high (*6*) (table 3). Treatments included mechanical removal of sagebrush; spray (herbicide applied with a ground sprayer); a check or no brush control on the ungrazed fenced areas; and grazed. Mechanical removal consisted of grubbing all sagebrush plants at ground level. Application rates of 2,4-D [*(2,4-dichlorophenoxy) acetic acid*] were purposely low (1.5 lb/acre), as recommended by the Bureau of Land Management. These dosages were lower than those recommended by Cornelius and Graham (*2*).

We used small exclosures to protect sampling areas within the grazed treatments from livestock. Grazing of the area surrounding the fenced exclosures was not controlled. Treatments were the same at each site, except at Whiskey Hill, where there was no mechanical removal of sagebrush, and at Sheep Creek, where 2,4,5-T [*(2,4,5-trichlorophenoxy) acetic acid*] was applied instead of 2,4-D.

TABLE 3.--*Types, rates, and dates of herbicide spray applications at brush treatment study sites*

Site	Herbicide	Rate applied	Date applied
		Pounds per acre	
Nancy Gulch	2,4-D[1]	1.5	May 1971
Whiskey Hill	2,4-D[1]	1.5	June 1972
Sheep Creek	2,4,5-T[1]	2.5	June 1969
Reynolds Mountain	2,4-D[1]	1.5	June 1971

[1]Formulated as a low volatile ester.

Sampling

Herbage yield was sampled at each site when the major grass species had formed seed (table 4). The nonwoody portion of the brush was considered annual growth and was the only portion sampled. Annual herbage production was determined for each treatment by estimating (green weight) and by actual weighing, using the double-sampling method described by Wilm et al. (*14*).

Each year, sample plots measuring 9.6 square feet were selected at random, clipped by species, field weighed, oven-dried, and reweighed. Green field weights were used to improve the accuracy of weight estimated on nonclipped plants. All sample weights were adjusted to an air-dry weight of 12 percent moisture. Treatments were applied once at each site. During harvest, 10 samples were taken at random from each treatment.

Statistical Analysis

Duncan's multiple range test for significance was applied for mean separation at the 5-percent probability level (*9*).

Table 4.--*List of primary plant species at brush treatment study sites*

Major plant species	Site			
	Nancy Gulch	Whiskey Hill	Sheep Creek	Reynolds Mountain
Big sagebrush				
Artemisia tridentata subsp. *wyomingensis*	x			
A. t. subsp. *vaseyana*		x	x	x
Sandberg bluegrass				
Poa sandbergii	x	x		
Cheatgrass				
Bromus tectorum	x	x		
Bearded bluebunch wheatgrass				
Apropyron spicatum	x			
Phlox				
Phlox sp.	x			
Idaho fescue				
Festuca idahoensis		x		
Needleandthread				
Stipa comata			x	x
Slender wheatgrass				
Agropyron trachycaulum			x	
Mountain bromegrass				
Bromus marginatus			x	x
Sedges				
Carex sp.				x
Snowberry				
Symphoricarpos oreophilus			x	

RESULTS AND DISCUSSION

Total Current Forage Yields

Total annual forage yields did not differ significantly among treatments at Nancy Gulch, Whiskey Hill, or Sheep Creek (fig. 3 *A*, *B*, and *C*). This indicated forage yield had been replaced by herbaceous yield following either mechanical or spray treatment. Total average annual yields varied from 694 lb/acre at Nancy Gulch to 1,577 lb/acre at Sheep Creek, reflecting differences in precipitation and soil between sites. At the Reynolds Mountain site, total yields were 1,024 and 902 lb/acre on the mechanically treated and sprayed plots, respectively, and were about 450 lb/acre less than those from the untreated and grazed plots (fig. 3 *D*). Spraying at the optimum time killed most of the sagebrush at Reynolds Mountain. Dense stands of grasses and forbs developed on both the mechanically treated and sprayed plots during the year after treatment. Total yields varied among years in response to variations in spring precipitation. For example, in 1971, the total precipitation during April, May, and June was 5.63 inches at Whiskey Hill and 10.16 inches at Reynolds Mountain. In 1974, spring precipitation totaled only 1.57 inches and 3.18 inches, respectively. Yields for individual years are given in Appendix table 1, along with average yields for the sites.

Understory Yields

Nancy Gulch.--Herbage or nonsage yields at Nancy Gulch were significantly greater where sagebrush was removed mechanically than those for either the untreated or grazed plots (fig. 4 *A*). The sprayed plot produced 487 lb/acre of herbage, which was not significantly different from that produced on either the untreated or the grazed plots. Sagebrush kill at this low moisture site was 65 to 70 percent. Conditions apparently were not favorable for growth at the time of spraying, as discussed by Hyder and Sneva (*5*). Herbicide was applied at the recommended rate when Sandberg bluegrass (*Poa sandbergii*) had headed and was maturing. The presence of numerous uncontrolled sagebrush plants on the sprayed plot probably did not permit the optimum growth of the understory grasses and forbs.

Whiskey Hill.--The 765 lb/acre yields produced on the 2,4-D treated plot were significantly higher than those for either the untreated or grazed plots (fig. 4 *B*).

Sheep Creek.--Sagebrush kill exceeded 95 percent at the Sheep Creek site. The yield from the sprayed plot was significantly greater than that from the grazed or untreated plot (fig. 4 *C*). Herbage yields from the mechanically treated plots were significantly greater than those from untreated or grazed plots but were not as high as those from the sprayed plot. After 4 years, some sagebrush reinvasion was noted on the mechanically treated plot, which may have been a contributing factor to the depressed yield. By 1974, the sagebrush had reached a height of 12 inches and was primarily the result of regrowth of stumps that had not been completely uprooted. There was very little evidence of sagebrush seedlings. The grazed treatment produced significantly more (155 lb/acre) herbage than the untreated plot. At the Sheep Creek site, grass was vigorous in the middle of the summer, and abundant seed production was observed during the year following mechanical or spray treatment. Robertson (*11*) also noted increased grass seed production resulting from sagebrush eradication.

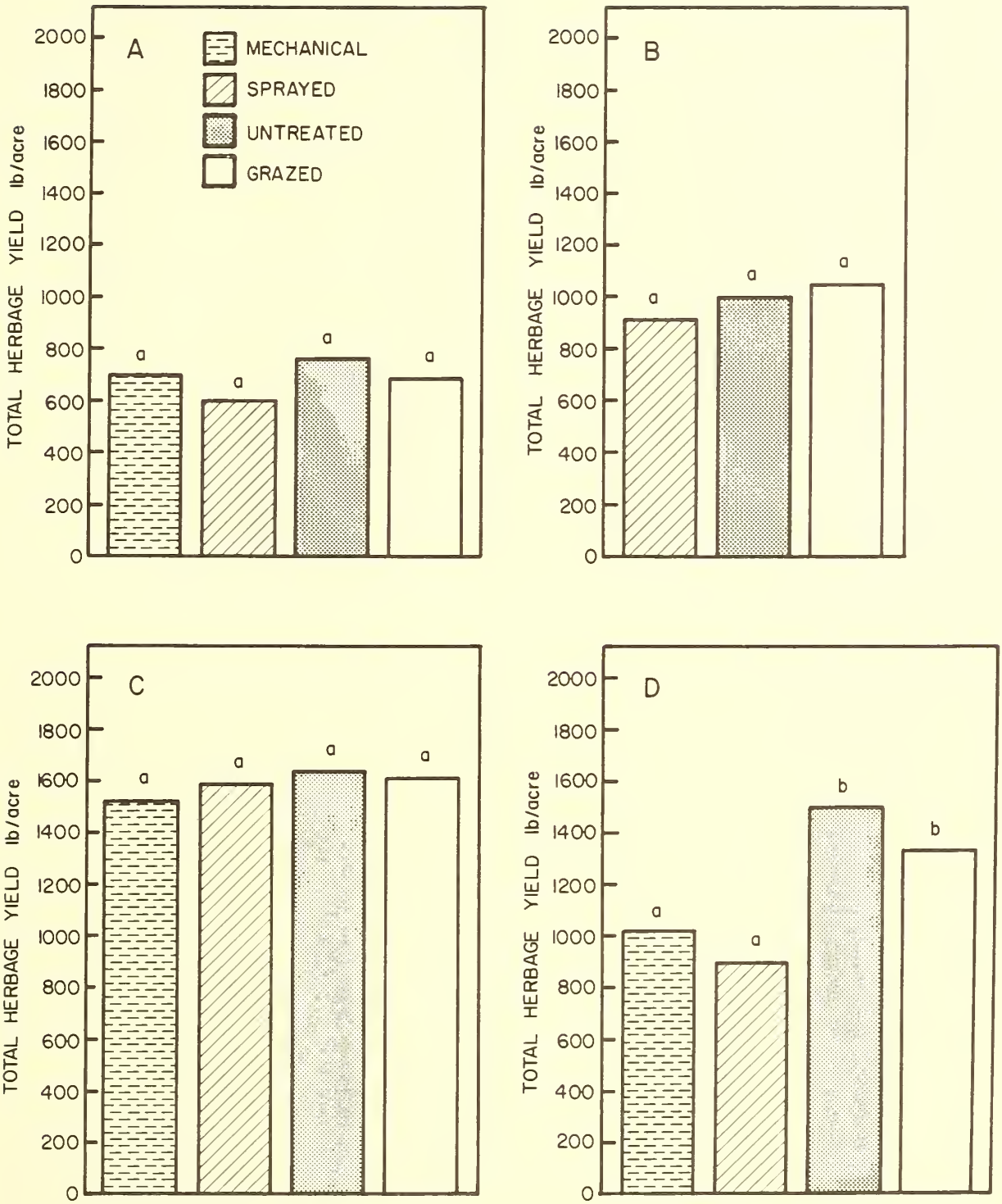

Figure 3.--Annual yield of current production for brush treatment sites: *A*, Nancy Gulch, 1972-75 average; *B*, Whiskey Hill, 1973-75 average; *C*, Sheep Creek, 1971-75 average; and, *D*, Reynolds Mountain, 1972-75 average. A different letter above a column indicates a significant difference from other treatments at the 5-percent level.

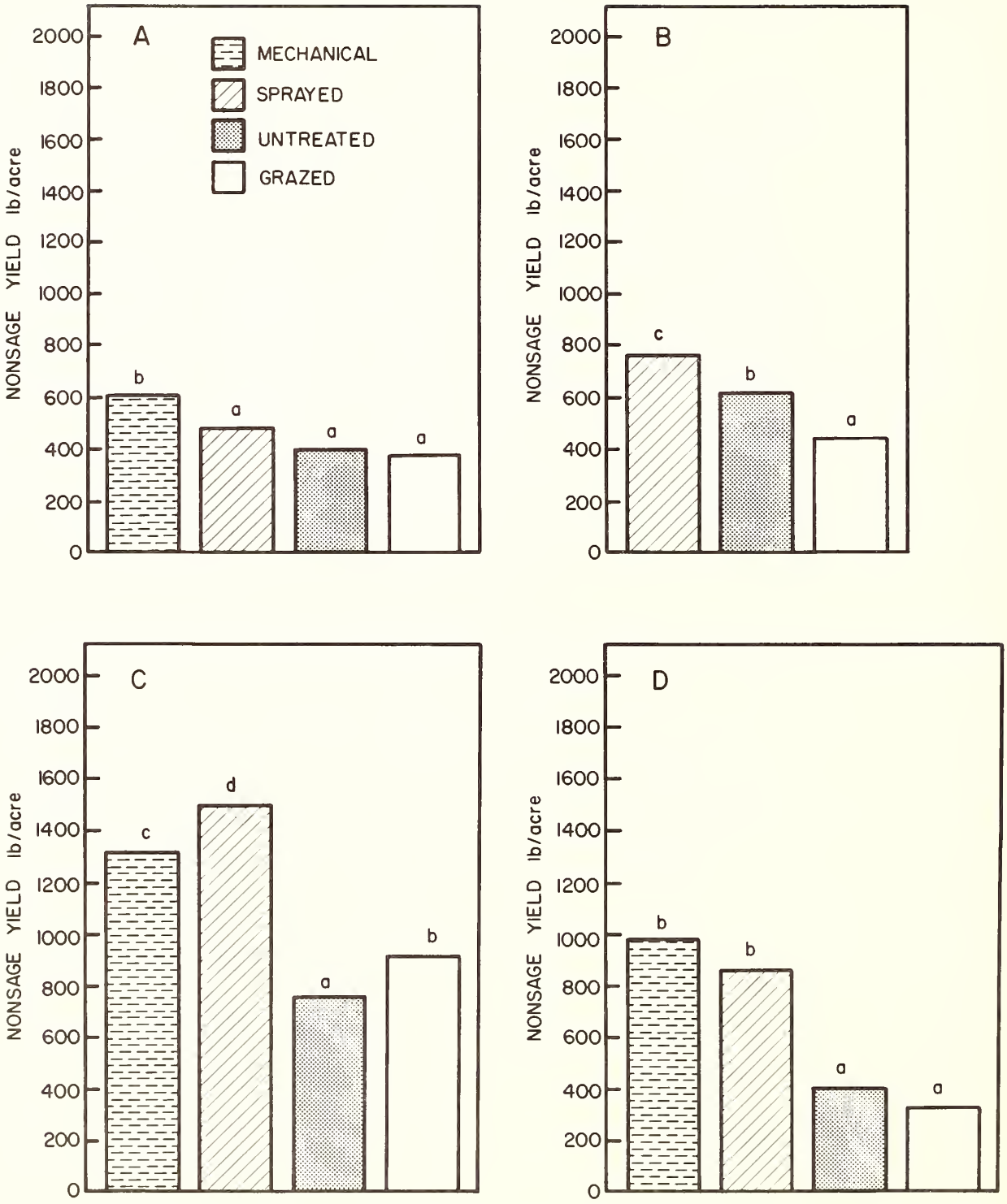

Figure 4.--Nonsage or understory vegetation yields for brush treatment sites: *A*, Nancy Gulch, 1972-75 average; *B*, Whiskey Hill, 1973-75 average; *C*, Sheep Creek, 1971-75 average; and, *D*, Reynolds Mountain, 1972-75 average. A different letter above a column indicates a significant difference from other treatments at the 5-percent level.

Reynolds Mountain.--Understory herbage yields from both the mechanically treated and sprayed plots were similar and exceeded those yields from the untreated and grazed plots. The shorter growing season at Reynolds Mountain may account for yields lower than those at Sheep Creek (fig. 4 *D*). In the spring, snow remains longer at this high elevation site. As with total yield, nonsage yields varied from year to year. Average nonsage production for each year of the study is given in Appendix table 1.

Species Composition

Species composition, based on weight, also changed during this study. Table 5 compares average 1974 and 1975 yield of the primary species on the untreated plot with the other treatments.

Yield of bluegrass (*Poa* sp.) did not change regardless of treatment or site. The *Poa* species were present at all four sites with no increase or decrease in yield evident, as compared with the check. Either bottlebrush squirreltail (*Sitanion hystrix*) or foxtail barley (*Hordeum jubatum*) was found at all study sites. Yields increased after mechanical treatment at the Nancy Gulch, Sheep Creek, and Reynolds Mountain sites. They also increased on the sprayed plots at Nancy Gulch, Sheep Creek, and Reynolds Mountain, but not at the Whiskey Hill site. After mechanical removal of sagebrush, bearded bluebunch wheatgrass (*Agropyron spicatum*) increased at Nancy Gulch and slender wheatgrass (*Agropyron trachycaulum*) increased at the Sheep Creek and Reynolds Mountain sites. The wheatgrasses also increased at Nancy Gulch, Whiskey Hill, and Sheep Creek after spraying. Cheatgrass (*Bromus tectroum*) increased after treating mechanically or spraying at Nancy Gulch and after spraying at Whiskey Hill. Mountain bromegrass (*Bromus marginatus*) was greater on both mechanical and spray-treatment plots than that on untreated plots at Sheep Creek and Reynolds Mountain. Needleandthread (*Stipa comata*) increased on mechanical and spray-treatment plots at Sheep Creek and Reynolds Mountain. It also increased on the grazed plot at Sheep Creek. Idaho fescue (*Festuca idahoensis*) decreased with grazing at Whiskey Hill, as compared with the untreated and herbicide treatments.

Lupine (*Lupine* sp.) composition decreased where herbicide was applied, although only slightly at Reynolds Mountain, while there was a distinct increase after mechanical treatment at this site (36 percent of the total herbage production). Lupine was also present on the other treatments, but was only 6 to 12 percent of the total production. At Sheep Creek, effects of 2,4,5-T probably reduced the presence of lupine on the spray plot. Lupine was not present at the Nancy Gulch site.

Phlox (*Phlox hoodii*) increased following either brush treatment method at Nancy Gulch, although less than 50 lb/acre herbage was produced.

Studies by Harniss and Murray (*3*) showed that sagebrush yields increased in time after sagebrush treatment, while grass and forb yields decreased. To show any changes over the study period, our yield data were grouped according to grasses, forbs, or sagebrush and are expressed as a percentage of the total yield for each treatment in figure 5.

Nancy Gulch.--Sagebrush composition remained at a low level of 0 to 15 percent of the total composition on the mechanically treated plots during the study (fig. 5 *A*). From 1972 to 1975, 20 percent or more sagebrush grew on the sprayed plot, indicating that kill from the original spray treatment was ineffective.

TABLE 5.--*Yield by species at brush treatment study sites (average of 1974 and 1975)*

Location and species	Mechanical	Sprayed	Untreated	Grazed
	----------*Pounds per acre*----------			
Nancy Gulch:				
Sandberg bluegrass (*Poa sandbergii*)	160.3	145.1	153.0	161.7
Bottlebrush squirreltail (*Sitanion hystrix*)	89.8	68.4	53.2	39.5
Bearded bluebunch wheatgrass (*Agropyron spicatum*)	57.8	45.5	4.5	7.4
Cheatgrass (*Bromus tectorum*)	57.5	26.4	5.8	6.4
Phlox (*Phlox* sp.)	46.7	40.6	15.7	2.4
Eriogonum (*Eriogonum* sp.)	139.0	67.2	62.9	127.0
Other forbs	63.2	55.6	54.0	40.2
Little-leaf horsebrush (*Tetradymia glabrata*)	.4	10.2	21.3	--
Big sagebrush (*Artemisia tridentata* subsp. *wyomingensis*)	73.7	119.3	398.9	236.6
Whiskey Hill:				
Bearded bluebunch wheatgrass (*Agropyron spicatum*)	--	107.7	30.8	11.1
Cheatgrass (*Bromus tectorum*)	--	217.9	88.9	99.2
Idaho fescue (*Festuca idahoensis*)	--	79.1	62.3	8.2
Sandberg bluegrass (*Poa sandbergii*)	--	37.5	20.6	19.3
Bottlebrush squirreltail (*Sitanion hystrix*)	--	30.6	25.8	47.2
Needleandthread (*Stipa comata*)	--	--	.6	3.2
Arrowleaf balsamroot (*Balsamorhiza hookeri*)	--	5.5	43.6	17.3
Lupine (*Lupin* sp.)	--	--	13.9	35.3
Other forbs	--	181.5	268.5	194.9
Lanceleaf rabbitbrush (*Chrysothanmus viscidiflorus* subsp. *lanceolatus*)	--	35.1	70.6	76.2
Big sagebrush (*Artemisia tridentata* subsp. *vaseyana*)	--	133.9	327.4	611.0
Sheep Creek:				
Slender wheatgrass (*Agropyron trachycaulum*)	178.5	142.3	73.4	--
Foxtail barley (*Hordeum jubatum*)	107.5	179.2	76.4	13.2
Needleandthread (*Stipa comata*)	77.6	47.1	31.8	75.0
Mountain bromegrass (*Bromus marginatus*)	24.1	49.2	1.0	1.5
Idaho fescue (*Festuca idahoensis*)	1.9	5.6	12.4	1.3
Bluegrass (*Poa* sp.)	10.6	28.6	23.6	2.5
Sedges (*Carex* sp.)	7.6	21.4	--	--
Other grasses	--	3.9	3.8	1.4
Lupine (*Lupin* sp.)	105.0	6.9	51.9	202.8
Other forbs	322.5	111.3	103.9	299.0
Snowberry (*Symphoricarpos oreophilus*)	21.4	77.6	85.8	40.6
Lanceleaf rabbitbrush (*Chrysothanmus viscidiflorus* subsp. *lanceolatus*)	16.0	23.6	8.8	--
Big sagebrush (*Artemisia tridentata* subsp. *vaseyana*)	369.9	68.0	904.7	801.0
Reynolds Mountain:				
Slender wheatgrass (*Agropyron trachycaulum*)	142.1	20.8	14.0	2.3
Mountain bromegrass (*Bromus marginatus*)	82.0	133.6	20.6	21.8
Needleandthread (*Stipa comata*)	116.0	166.0	11.8	19.5
Sedges (*Carex* sp.)	81.8	194.2	117.2	33.7
Foxtail barley (*Hordeum jubatum*)	72.1	71.0	5.7	9.2
Bluegrass (*Poa* sp.)	11.3	8.4	.4	9.2
Idaho fescue (*Festuca idahoensis*)	--	--	--	--
Lupine (*Lupin* sp.)	405.8	77.0	100.7	176.5
Other forbs	144.4	159.0	176.6	127.0
Snowberry (*Symphoricarpos oreophilus*)	1.0	--	--	17.5
Big sagebrush (*Artemisia tridentata* subsp. *vaseyana*)	44.4	89.1	1031.2	957.9

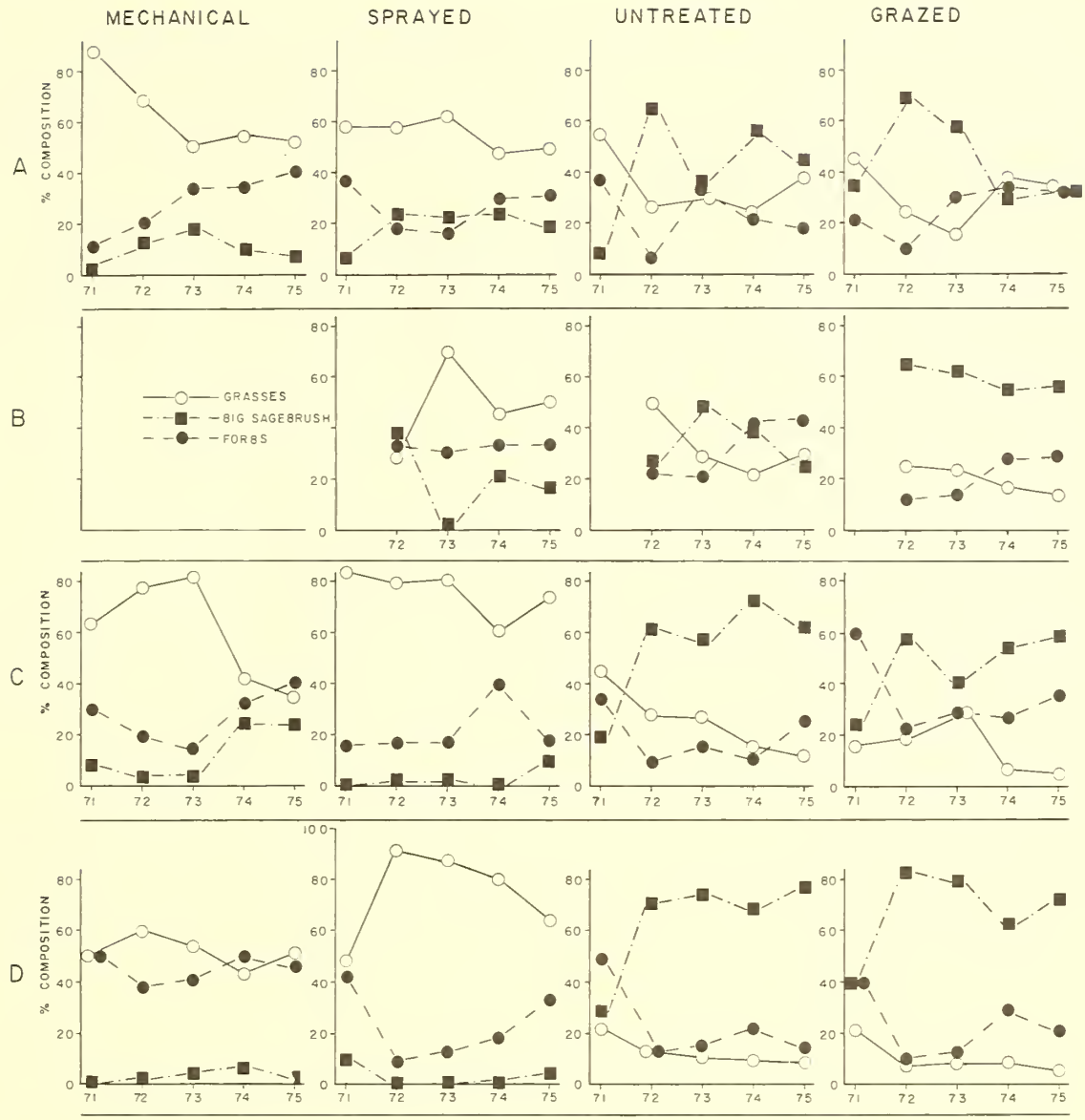

Figure 5.--Percent composition by weight (vertical axis) and by year (horizontal axis) of big sagebrush, grasses, and forbs from brush treatments. Sites are: *A*, Nancy Gulch; *B*, Whiskey Hill; *C*, Sheep Creek; and *D*, Reynolds Mountain. Open circle indicates grasses; closed circle, forbs; and closed square, big sagebrush.

Whiskey Hill.--The effects of the 1972 herbicide treatment were not fully evident until 1973. Species composition of the untreated plot did not change during the period of study, although year-to-year fluctuations were evident. On the grazed plot, the sagebrush composition remained near 60 percent, while grasses and forbs remained low, with combined totals of 40 percent during the study period (fig. 5 *B*).

Sheep Creek.--Although sprayed in 1969, data for plant composition were not collected until 1971 at Sheep Creek. Sagebrush composition was less than 10 percent on the mechanically treated plot until 1974, when young seedling plants were more numerous and had increased in size (fig. 5 *C*). Cook and Lewis (*1*) found more than 70 percent of the reinvading sagebrush 2 years after brush was removed. On the mechanically treated plot, grass composition increased through 1973 and then declined, with a corresponding increased in forbs and sagebrush. Grass composition remained high on the sprayed treatment during the study period after reaching 80 percent of the total composition. Grass and forb composition on the untreated and grazed plots was the minor component from 1972 through 1975, with combined totals less than 40 percent.

Reynolds Mountain.--Species composition remained fairly constant on the mechanically treated plot during the study at Reynolds Mountain. Although the sagebrush was dying, some dry matter was measured in 1971 several months after spraying. Grasses increased to 90 percent of the composition by 1972 on sprayed plots, but decreased during the remaining years of the study as forb composition increased (fig. 5 *D*). Sagebrush was definitely the major component on the untreated and grazed plots during the study period.

There was no evidence of young sagebrush seedlings on the sprayed plots during the study period. Studies conducted by Johnson (*7*) showed that sagebrush seedlings were most numerous when 40 to 60 percent of the original sagebrush plants were killed, whereas Weldon et al. (*13*) showed that applying 2,4-D, controlled seedlings well. Long-term effects of sagebrush control are not available; however, in about 15 years, respraying should be necessary (*8*).

SUMMARY AND CONCLUSIONS

Mechanical treatment of sagebrush allowed abundant production of understory grasses and forbs at all study sites, but the increase in growth was greatest when compared with the untreated plots at sites with higher amounts of precipitation. By using herbicides to control sagebrush, herbage yields were significantly greater at three of the sites. Competition between grass and sagebrush caused the low nonsage yields at the drier Nancy Gulch site.

Mechanically removing sagebrush resulted in an increase in the grasses' contribution to total herbage production; however, grasses decreased at two sites a few years after treatment because of sagebrush regrowth. Sagebrush seedlings increased in size during the study period at Sheep Creek and resulted in 20 percent of the plant composition at the end of the study. Using herbicides to control sagebrush caused a distinct change in plant composition during the study at the higher precipitation sites where there was a very good sagebrush kill; sagebrush regrowth was minimal.

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APPENDIX

TABLE 1.--*Yield by years at brush treatment study sites*

Site and year of study	Total yield				
	Mechanical	Sprayed	Untreated	Grazed	Site Average
	Pounds per acre				
Nancy Gulch:					
1972	298	466	500	338	
1973	1,135	705	1,028	1,202	
1974	721	683	911	626	
1975	702	540	636	607	
Average	714	599	769	693	694
Whiskey Hill:					
1973	--	542	842	843	
1974	--	1,104	1,119	903	
1975	--	1,066	1,014	1,379	
Average	--	904	992	1,042	979
Sheep Creek:					
1971	2,460	3,432	2,104	2,860	
1972	1,047	825	1,079	1,185	
1973	1,754	2,171	2,025	1,135	
1974	914	672	1,574	1,614	
1975	1,231	822	1,387	1,241	
Average	1,481	1,584	1,634	1,607	1,577
Reynolds Mountain:					
1972	695	749	1,131	1,164	
1973	967	821	1,783	1,389	
1974	1,058	844	1,445	1,195	
1975	1,374	1,193	1,623	1,588	
Average	1,024	902	1,496	1,334	1,189
	Nonsage yield				
Nancy Gulch:					
1972	258	356	173	108	
1973	912	636	684	524	
1974	645	518	396	440	
1975	637	439	354	406	
Average	613	487	402	370	468
Whiskey Hill:					
1973	--	531	393	310	
1974	--	851	695	410	
1975	--	912	754	605	
Average	--	765	614	442	607

TABLE 1.--*Yield by years at brush treatment study sites*-Continued

Site and year of study	Total yield				
	Mechanical	Sprayed	Untreated	Grazed	Site Average
	Pounds per acre				
Sheep Creek:					
1971	2,239	3,064	1,558	2,093	
1972	1,005	805	409	524	
1973	1,687	2,171	860	656	
1974	686	672	424	734	
1975	952	757	535	552	
Average	1,314	1,494	757	912	1,119
Reynolds Mountain:					
1972	679	749	301	207	
1973	925	821	451	297	
1974	995	833	465	384	
1975	1,324	1,049	400	436	
Average	981	863	404	331	645

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